APPENDIX E

Staff Analysis of Future Emission Benefits of California's Diesel Fuel Program

VI. 2000-2020 Statewide Diesel NOx and PM Emission Reductions: Mobile Source

To estimate statewide NOx and PM emission reductions from on-road diesel vehicles and off-road diesel engines, CY 2000-2020, staff used the ARB's EMFAC2002 model (version 2.2) and OFFROAD model.

The on-road vehicles were categorized into four groups, uncontrolled and Tier I-III groups, based on the engine standards that apply to heavy heavy-duty diesel trucks, while the off-road engines were lumped together into one group. Table 10 shows this grouping, along with emission reduction factors by pollutant and source category. These factors were bifurcated according to diesel fuel regulations: the current (500 ppmw S and 10 percent aromatics) and proposed (15 ppmw S). For example, it can be seen in Table 10, in 2006 and beyond no additional NOx emission benefits from on-road vehicles were estimated due to the proposed 15 ppmw S diesel fuel regulations, but these vehicles would produce an additional 4 percent PM emission benefits, except in Tier III group.

Using these assumptions, Table 11 shows 2000-2020 statewide NOx emission reductions. These reductions range from 110 tons per day (tpd) in 2000 to 35 tpd in 2020, as shown in Figure 3. The importance of the 10 percent aromatic requirement in the current diesel regulations in the future can be seen in Figure 4, where older group of vehicles (uncontrolled) still account for one half of the total on-road emission reductions in 2010-2020. Similarly, the off-road engines are the major contributors in the overall emission reductions, increasing from about 50 percent of total mobile source in 2010 to 65 percent in 2020.

Unlike NOx, the proposed 15 ppmw S regulations would provide additional PM_{10} emission reductions from on-road vehicles, about 0.5 tpd in 2010 to 0.2 tpd in 2020 (Table 12). However, off-road engines were not included in this analysis due to uncertainty of when the proposed low sulfur regulations would take effect in this source category. Figure 3 shows the combined statewide PM_{10} reductions due to the current and proposed diesel fuel regulations. As can be seen in Figure 4, off-road engines would be the main source of PM_{10} emissions reductions from mobile source in the future.

Table 10. Diesel Fuel Emission Reduction Factors

By Pollutant, Source Category, and Technology Group

Oxides of Nitrogen:

HD Diesel Engine Tech Group (Emission Standards, Model Year)	Emission Reduction Factors (500 ppmw S) (Calendar Year 1993-2006)
On-Road:	
Uncontrolled (>4 g/bhphr NOx, >0.1 g/bhphr PM; pre 1998)	7%
Tier I (4 g/bhphr NOx, 0.1 g/bhphr PM; 1998-2003)	7%
Tier II (2 g/bhphr NOx, 0.1 g/bhphr PM; 2004-2006)	6%
Off-Road:	
All tech groups	7%

HD Diesel Engine Tech Group (Emission Standards, Model Year)	Additional Emission Reduction Factors (15 ppmw S)* (Calendar Year 2006-beyond)
On-Road:	
Uncontrolled (>4 g/bhphr NOx, >0.1 g/bhphr PM; pre 1998)	0%
Tier I (4 g/bhphr NOx, 0.1 g/bhphr PM; 1998-2003)	0%
Tier II (2 g/bhphr NOx, 0.1 g/bhphr PM; 2004-2006)	0%
Tier III (0.2 g/bhphr NOx, 0.01 g/bhphr PM; post-2006)	0%
Off-Road:	
All tech groups	same as above

Particulate Matter:

HD Diesel Engine Tech Group (Emission Standards, Model Year)	Emission Reduction Factors (500 ppmw S) (Calendar Year 1993-2006)
On-Road:	
Uncontrolled (>4 g/bhphr NOx, >0.1 g/bhphr PM; pre 1998)	25%
Tier I (4 g/bhphr NOx, 0.1 g/bhphr PM; 1998-2003)	25%
Tier II (2 g/bhphr NOx, 0.1 g/bhphr PM; 2004-2006)	25%
Off-Road:	
All tech groups	same as above

HD Diesel Engine Tech Group (Emission Standards, Model Year)	Additional Emission Reduction Factors (15 ppmw S)* (Calendar Year 2006-beyond)
On-Road:	
Uncontrolled (>4 g/bhphr NOx, >0.1 g/bhphr PM; pre 1998)	4%
Tier I (4 g/bhphr NOx, 0.1 g/bhphr PM; 1998-2003)	4%
Tier II (2 g/bhphr NOx, 0.1 g/bhphr PM; 2004-2006)	4%
Tier III (0.2 g/bhphr NOx, 0.01 g/bhphr PM; post-2006)	0%
*Off-Road:***	
All tech groups	same as above

*Relative to uncontrolled diesel fuel

**Off-road model (recreation vehicles, off-road equipment, and farm equipment) does not include the proposed 15 ppmw S regulations.

Table 11. 2000-2020 Statewide Mobile Source NOx Emissions Reduction, Annual Average

Diesel Engines by Source Category and Technology Group

(EMFAC 2002, Ver. 2.2 and Emisssion Inventory Model, Base Year 2001)

Source Category / Tech Group			NOx Emission Reduction (tons/day)		
			500 S	15 S	Total
2000					
On-Road:	Uncontrolled, pre-1998		48	n/a	48
	Tier I, 1998-2003		12	n/a	12
		On-Road Subtotal	61	n/a	61
Off-Road:	All tech groups		49	n/a	49
		Total	**110**	**n/a**	**110**
2005					
On-Road:	Uncontrolled, pre-1998		33	n/a	33
	Tier I, 1998-2003		19	n/a	19
	Tier II, 2004-2006		4	n/a	4
		On-Road Subtotal	56	n/a	56
Off-Road:	All tech groups		45	n/a	45
		Total	**100**	**n/a**	**100**
2010					
On-Road:	Uncontrolled, pre-1998		19	0	19
	Tier I, 1998-2003		14	0	14
	Tier II, 2004-2006		5	0	5
	Tier III, post-2006		n/a	0	0
		On-Road Subtotal	38	0	38
Off-Road:	All tech groups		35	0	35
		Total	**73**	**0**	**73**
2015					
On-Road:	Uncontrolled, pre-1998		10	0	10
	Tier I, 1998-2003		8	0	8
	Tier II, 2004-2006		4	0	4
	Tier III, post-2006		n/a	0	0
		On-Road Subtotal	22	0	22
Off-Road:	All tech groups		27	0	27
		Total	**49**	**0**	**49**
2020					
On-Road:	Uncontrolled, pre-1998		6	0	6
	Tier I, 1998-2003		4	0	4
	Tier II, 2004-2006		2	0	2
	Tier III, post-2006		n/a	0	0
		On-Road Subtotal	12	0	12
Off-Road:	All tech groups		23	0	23
		Total	**35**	**0**	**35**

Figure 1
2000-2020 Statewide Total NOx Emissions Reduction, Annual Average
Mobile Source
(From uncontrolled to 15 ppmw S diesel fuel)

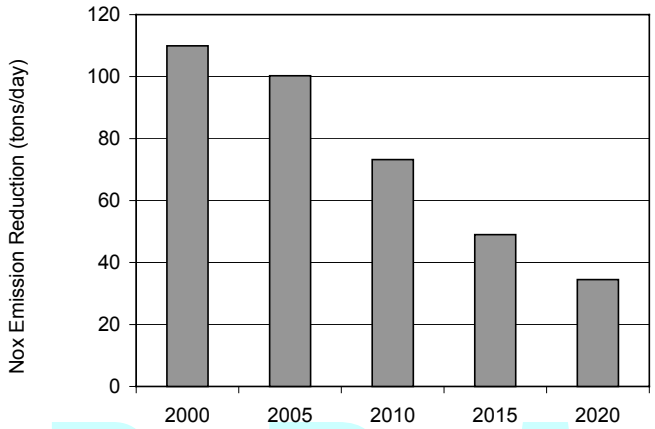

Figure 2
2000-2020 Statewide Total NOx Emissions Reduction, Annual Average
Mobile Source
Diesel Engines By Source Cetegory and Technology Group
(From uncontrolled to 15 ppmw S diesel fuel)

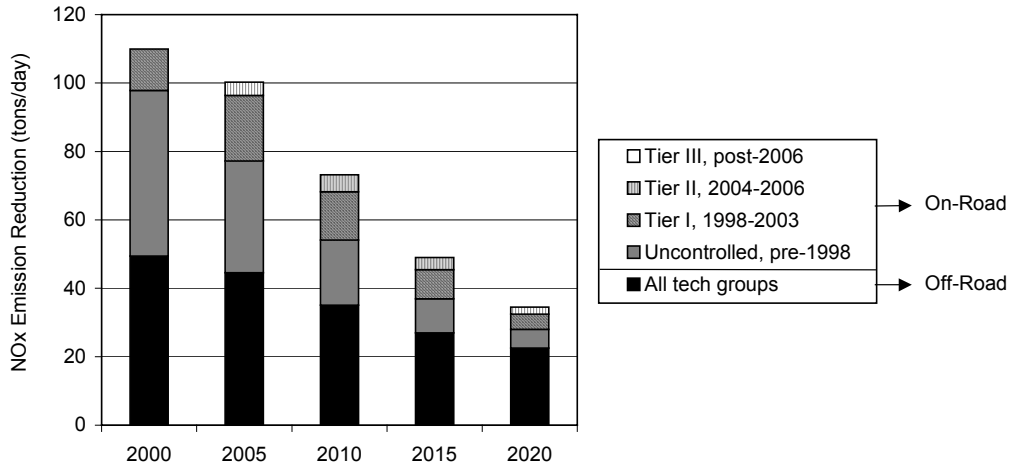

Table 12. 2000-2020 Statewide Mobile Source PM10 Emissions Reduction, Annual Average
Diesel Engines by Source Category and Technology Group
(EMFAC 2002, Ver. 2.2 and Emisssion Inventory Model, Base Year 2001)

Source Category / Tech Group			PM10 Emission Reduction (tons/day)		
			500 S	15 S	Total
2000					
On-Road:	Uncontrolled, pre-1998		5.1	n/a	5.1
	Tier I, 1998-2003		0.5	n/a	0.5
		On-Road Subtotal	5.5	n/a	5.5
Off-Road:	All tech groups		12.8	n/a	12.8
		Total	**18.3**	**n/a**	**18.3**
2005					
On-Road:	Uncontrolled, pre-1998		3.2	n/a	3.2
	Tier I, 1998-2003		1.0	n/a	1.0
	Tier II, 2004-2006		0.4	n/a	0.4
		On-Road Subtotal	4.6	n/a	4.6
Off-Road:	All tech groups		11.5	n/a	11.5
		Total	**16.0**	**n/a**	**16.0**
2010					
On-Road:	Uncontrolled, pre-1998		1.8	0.3	2.0
	Tier I, 1998-2003		0.8	0.1	0.9
	Tier II, 2004-2006		0.5	0.1	0.6
	Tier III, post-2006		n/a	0.0	0.0
		On-Road Subtotal	3.1	0.5	3.6
*Off-Road:**	All tech groups		9.0	n/a	9.1
		Total	**12.1**	**0.5**	**12.7**
2015					
On-Road:	Uncontrolled, pre-1998		0.9	0.2	1.1
	Tier I, 1998-2003		0.5	0.1	0.6
	Tier II, 2004-2006		0.4	0.1	0.5
	Tier III, post-2006		n/a	0.0	0.0
		On-Road Subtotal	1.8	0.3	2.1
*Off-Road:**	All tech groups		7.1	n/a	7.1
		Total	**8.9**	**0.3**	**9.2**
2020					
On-Road:	Uncontrolled, pre-1998		0.5	0.1	0.6
	Tier I, 1998-2003		0.3	0.0	0.3
	Tier II, 2004-2006		0.2	0.0	0.3
	Tier III, post-2006		n/a	0.0	0.0
		On-Road Subtotal	1.0	0.2	1.2
*Off-Road:**	All tech groups		5.7	n/a	5.7
		Total	**6.7**	**0.2**	**6.9**

*Off-road model does not include the proposed 15 ppmw S regulations

Figure 3
2000-2020 Statewide Total PM_{10} Emission Reduction, Annual Average
Mobile Source
(From uncontrolled to 15 ppmw S diesel fuel)

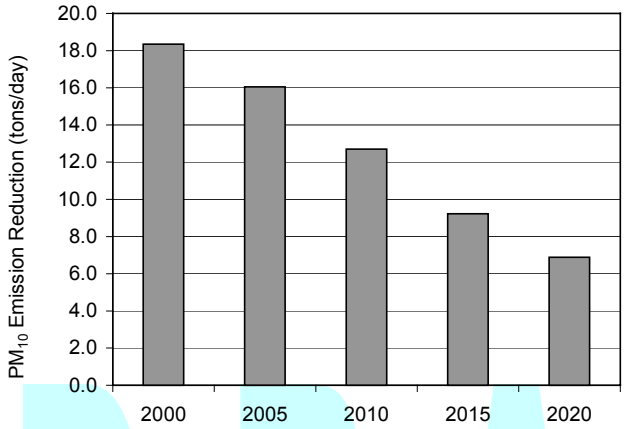

Figure 4
2000-2020 Statewide Total PM_{10} Emissions Reduction, Annual Average
Mobile Source
Diesel Engines By Source Cetegory and Technology Group
(From uncontrolled to 15 ppmw S diesel fuel)